and cost minimization under consideration of a reasonable number of generator starts per day. This optimal operation has been considered especially difficult in the case where the blackout duration of unreliable grid supply **17** is not known.

[0063] As described below, Problem I (i.e., fuel efficiency) is solved by use of prediction of load (and generation), and of, especially introduced, a blackout duration probability function to optimize the charge/discharge sequence of the battery and the generator operation. Since the reduction of fuel leads to reduction of overall cost, Problem II (i.e., cost minimization) is also solved. The fuel efficiency and cost minimization is guaranteed by a special optimization criteria which uses the unnecessary cost (UC), which combines penalizing poor generator operation (as it occurs in the low efficiency region of the generator), generator starts and charged battery at the end of the blackout. Since the optimization criteria include the generator starts, the problem of optimal operation with reasonable number of generator starts (i.e., Problem III) can be also solved by the exemplary embodiment.

[0064] Since the exact blackout occurrence is difficult or impossible to predict (Problem IV), the exemplary embodiment introduces an optimization method which is based on the blackout duration probability function, and outputs time variant discharge and charge limits which are used by a real time control module. For predicting the blackout duration probability function, the exemplary embodiment uses different available variables and introduces a special prediction method which is based on a database and artificial intelligence (e.g., ANN (artificial neural network), SVM (support vector machine), etc.) based predictors whose information is combined to get the blackout duration probability function.

[0065] In this way, the method of the exemplary embodiment relies on different kind of prediction (i.e., load, renewable, and blackout duration probability function) and a special optimization method taking into account the properties of the blackout duration distribution. The output of the optimization method are generally a time variant lower parameter and especially for a special variation discharging limit and a time variant upper charging limit for the real time control module which implements a policy considering these parameters.

[0066] Due to reduced computing power, it is preferable to use a system based on both local controller **20** with restricted computing resources and prediction server **20** with ample computing resources connected with local controller **15** via communication link **18**. In prediction server **30**, the computationally heavy tasks of the prediction and optimization can be carried out. If communication link **18** is weak or not available at all (which implies also no prediction server), the prediction and optimization functionality is partly or completely carried out in local controller **20** which asks for more computing power of the hardware on which local controller **20** is executed.

[0067] Next, details of the intelligent energy managements system (IEMS) according to the exemplary embodiment will be explained.

[0068] As described above, the IEMS consists of local controller **20** and, if available, prediction server **30**. Prediction server **30** runs typically on sophisticated hardware (e.g., a cloud solution) and has the capacity to run sophisticated prediction algorithms demanding speed and computing power. It is connected with communication link **18** for bidirectional communication (e.g., Internet, GPRS (General Packet Radio Service), GSM (Global System for Mobile communications), etc.) with local controller **20**. If prediction server **30** is available, demanding self-learning prediction algorithms on sophisticated hardware are executed by the prediction server and the results send to local controller **20**. If prediction server **30** is not available, the prediction is realized in local controller **20**.

[0069] In FIG. **4**, the simplest construction of prediction server **30** is shown. Prediction server **30** includes: load prediction module **31** predicting the power consumption of aggregated load **12**; and communication module **32** compressing the prediction data and transmitting the compressed data to local controller **20** via communication link **18**. If renewable generation **16** is available, renewable power generation prediction module **33** predicting the generated power of renewable generation **16** may be integrated to prediction server **30**. In the case of grid supply, blackout duration probability function prediction module **34** predicting the blackout duration probability function is also integrated to prediction server **30**. FIG. **5** illustrates prediction server **30** with renewable power generation prediction module **33** and blackout duration probability function prediction module **34**.

[0070] In prediction server **30**, the prediction data predicted by modules **31**, **33**, **34** are combined and compressed by communication module **32** and sent to local controller **20**. How large the prediction horizon and how the information compression in communication module **32** is carried out, depends on the physical and reliability, availability properties of communication link **18**. Depending on the quality and reliability of communication link **18**, communication module **32** may also contain the optimization method according to the present exemplary embodiment.

[0071] In FIG. **6**, the construction of local controller **20** is illustrated. Local controller **20** includes: real time control unit **21** controlling energy storage **11** and generator **13**; local renewable generation prediction module **22** predicting the generated power of renewable generation **16**; local load prediction module **23** predicting the power consumption of aggregated load **12**; local blackout duration probability function prediction module **24** predicting the blackout duration probability function; and local optimization module **25** optimizing the predicted data to send the result to real time control module **21**. The functionality of these three prediction modules **22** to **24** depends on the quality of the communication link **18**. In addition, real time control unit **21** includes a function of collecting, in real time, various measurement values related to the energy supply system.

[0072] If communication link **18** is of high quality, local prediction module **22** to **24** and local optimization module **25** are not needed. In this case, the optimization is carried out in prediction server **30**, and local controller **20** consists basically of real time control module **21**. Hardware requirements for implementation of local controller **20** are low in this case, since all computationally heavy tasks are carried out in prediction server **30**.

[0073] If communication link **18** is of low quality and unreliable, local prediction module **22** to **24** are used to correct the long term prediction obtained by server **30** based on the local measurements. Based on the corrected prediction, the optimization is carried out by local optimization module **25**. The hardware requirements for implementation of local controller **20** are intermediate in this case.